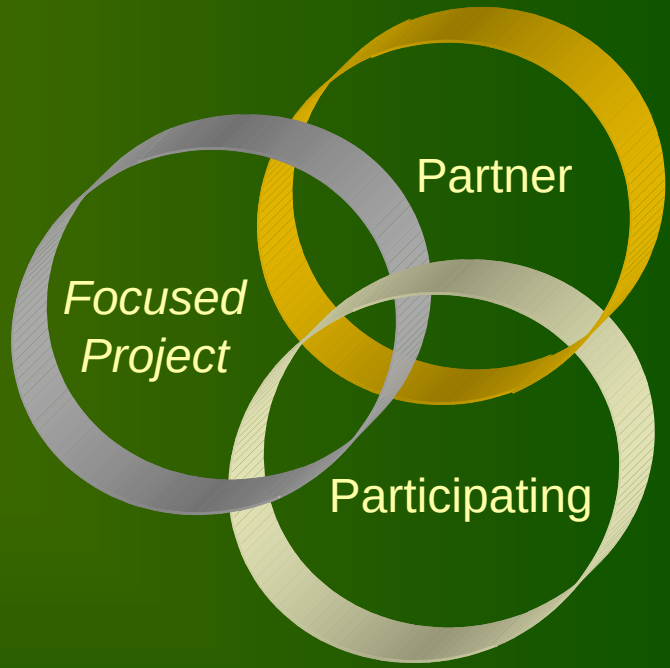
Focused Projects

- Focused Project Membership
  - Second level of NCMC activities
  - 2 to 4 members help fund one researcher
  - Semi-annual meetings
  - Quarterly and summary reports
  - Specifications for methods, instruments, programs, data analysis
- Help NCMC scientists set priorities in new areas with many opportunities (e.g. Microfluidics)
  - Choice of model systems and short term validation projects / focus areas
- Foster improved partnerships between members
  - Supplier / Customer



NCMC Membership Options

Projects

- Integration of Modular Measurement Platform for High Throughput Analysis of Polymer Solutions and Blends (Kate Beers)
  - Draft Documents
  - Anticipated start date: July 1, 2003
- High Throughput Methods of Measuring Interfacial Tension (Steve Hudson)
  - Currently one member
  - Start date: June 1, 2003
- High Throughput Methods for the Evaluation of Adhesion Performance (Chris Stafford)
  - Draft Documents
  - Anticipated start date: July 1, 2003
- Q & A Session

All of the research carried out in a Focused Project is non-proprietary and is intended for publication in the public domain. No proprietary information or materials will be solicited or accepted by NIST from member organizations.

Integration of Modular Measurement Platform for High Throughput Analysis of Polymer Solutions and Blends

Polymer Formulations Project

- Complex mixtures with multiple component types
- Experience, empirical models and trial and error in the past
- Polymer blends and solutions play a critical role

⇨

Personal Care: $ 26 billion (1999)
Detergents: $ 4.7 billion* (1999)
Fabric Softener: $ 1.3 billion* (1999)
Coatings: $ 21.2 billion** (2000)

Kline and Co.
*Information Resources Inc.
** PGPhillips and Assoc.

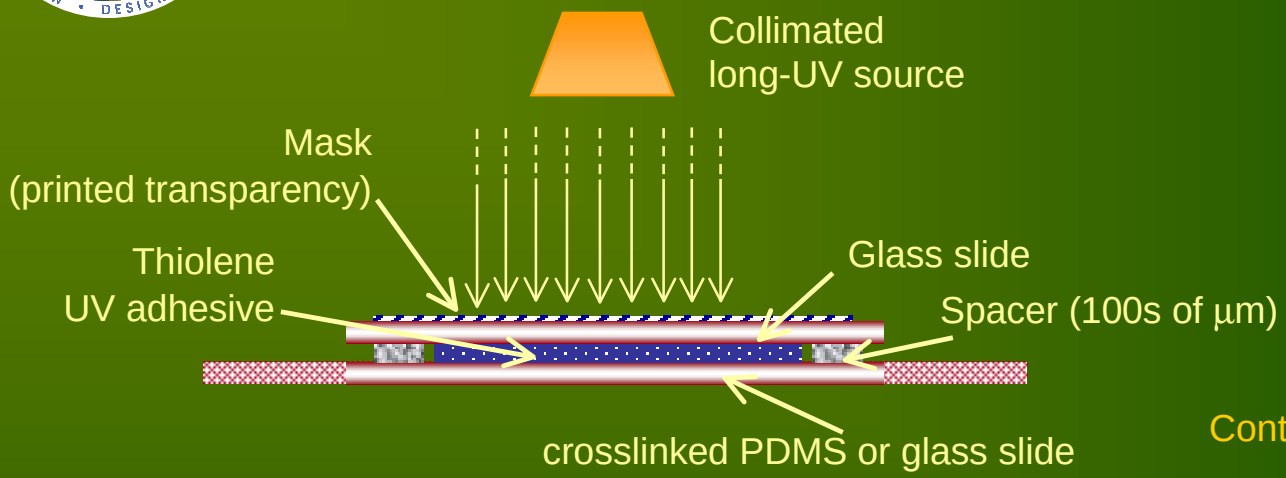
Focused Project Objective

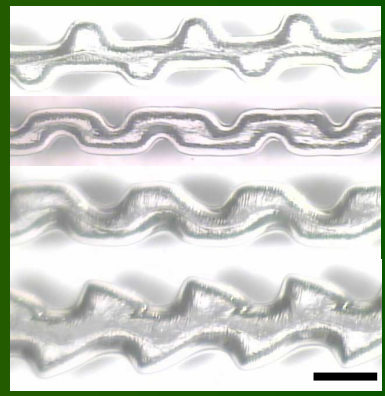
Development of new integrated measurement technologies that provide rapid development and cost effectiveness despite the complex, multi-parameter space of the polymeric formulations

⇩

MICRO- AND MESO-FLUIDICS

Background





Control lateral dimensions (mask & collimation)

Control vertical dimensions (UV dose and spacer)

Rapid prototyping technique for fabrication of fluidic channels in a solvent-resistant polymeric matrix

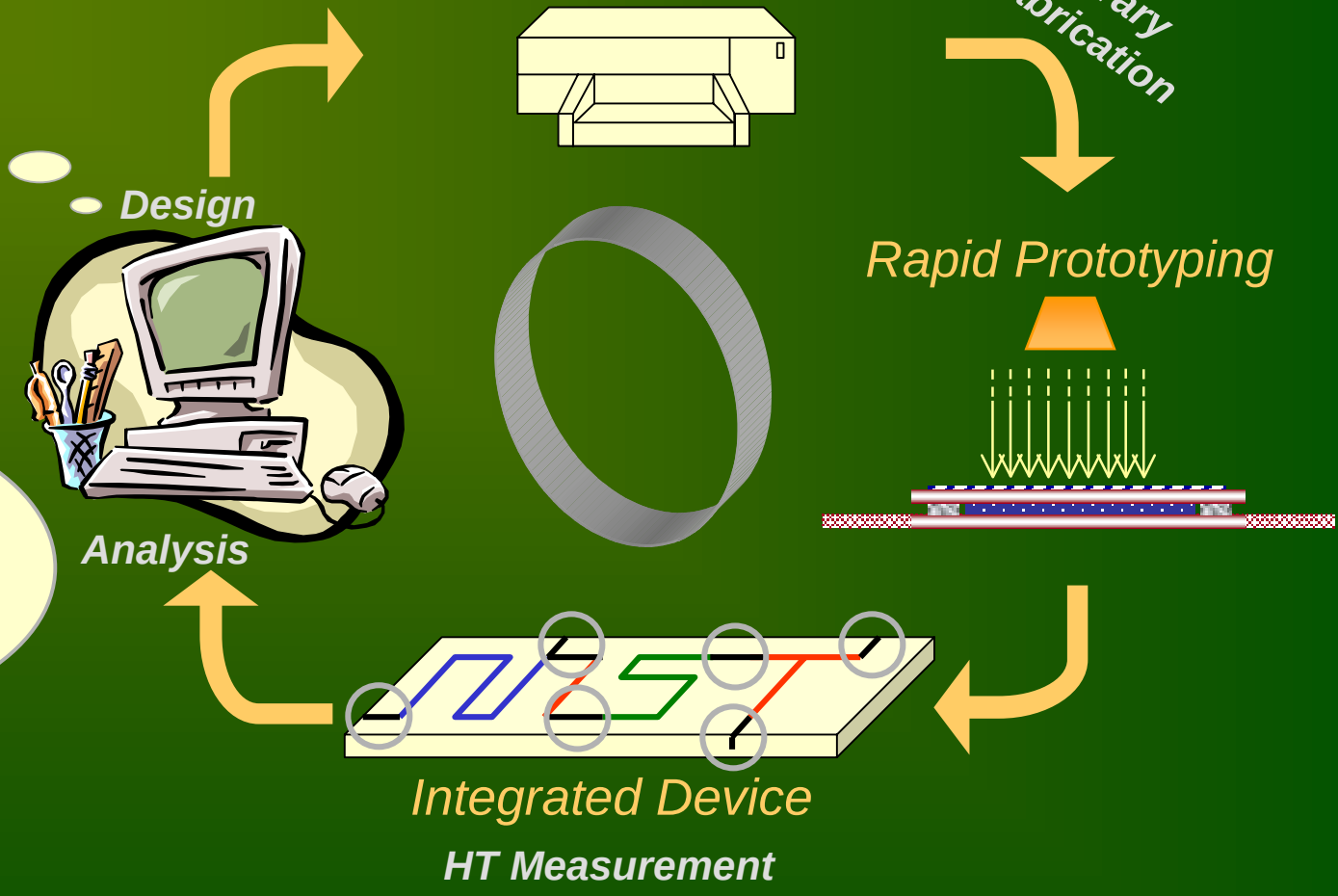
- Conventional contact lithography
- Commercially available thiolene-based adhesive
- Matrix can be crosslinked UV curable adhesive and glass (solvent resistant) or, be transferred to PDMS and sealed against glass (aqueous applications)
- Both result in optically transparent, sealed, micro/millimetric fluid handling devices.

J. Cabral
C. Harrison

Integration Goals

TOOLSET:
Synthesis
Processing
Measurement

plus:
Input / Output*
Control / Monitoring
*Connection to other COMBI tools

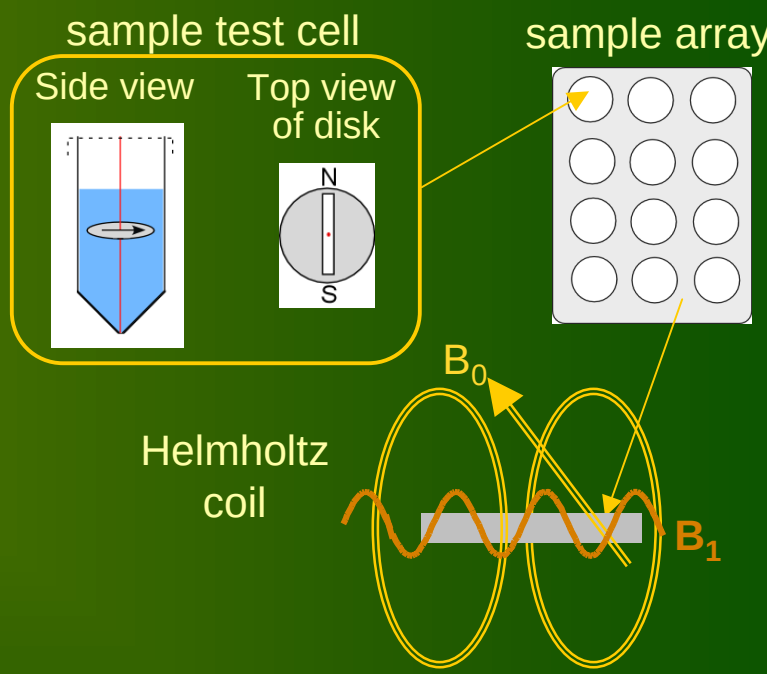


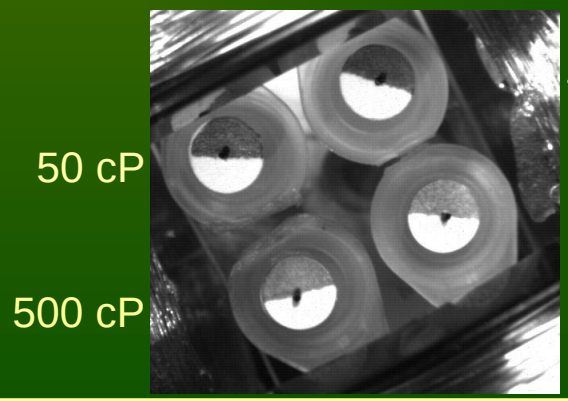
Formulations Toolset

- Mixing / Processing strategies
  - Active vs. passive mixing, solvents, concentrations, temperature
- Properties Measurements
  - Rheology
  - Interfacial Behavior (Blends)
    - Interfacial tension measurements (FP)
    - Phase diagrams (*new* scattering platforms)
- Other Tools
  - Polymer Synthesis
    - Varying compatibilizer compositions (statistical copolymers)
    - Preparation of colloidal particles in situ
- Other Related Projects:
  - Adhesion and Mechanical Properties (FP)
    - Link to existing platforms for characterizing thin films

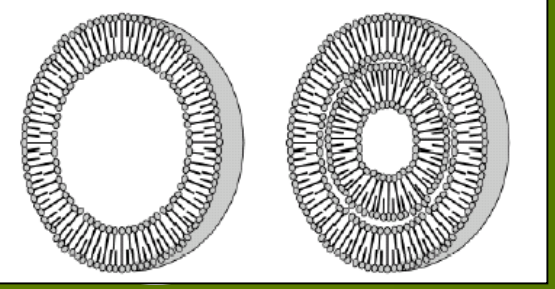
Measurement Example

- High Throughput Rheology
  - Ideal device can also study gelling and curing and is insensitive to solvents and complexity of system studied (*vs*. capillary viscometer)
- Principle of operation
  - Disc or cylinder immersed in liquid
  - Tiny bar magnet attached to disc aligns with a static magnetic field B_0
  - Helmholtz coil provides uniform, controllable, oscillating magnetic field B_1
  - Disk (or cylinder) oscillates in amplitude and phase in direct relation to the viscosity (η) and viscoelasticity (η^*) of the fluid.





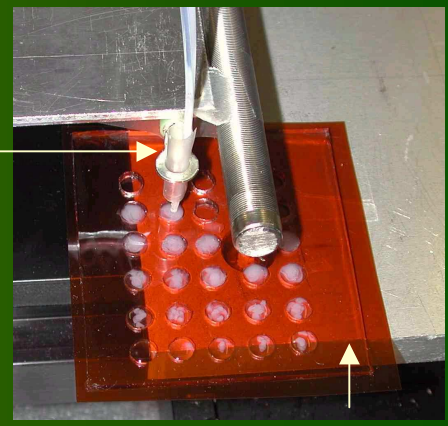
H. Walls



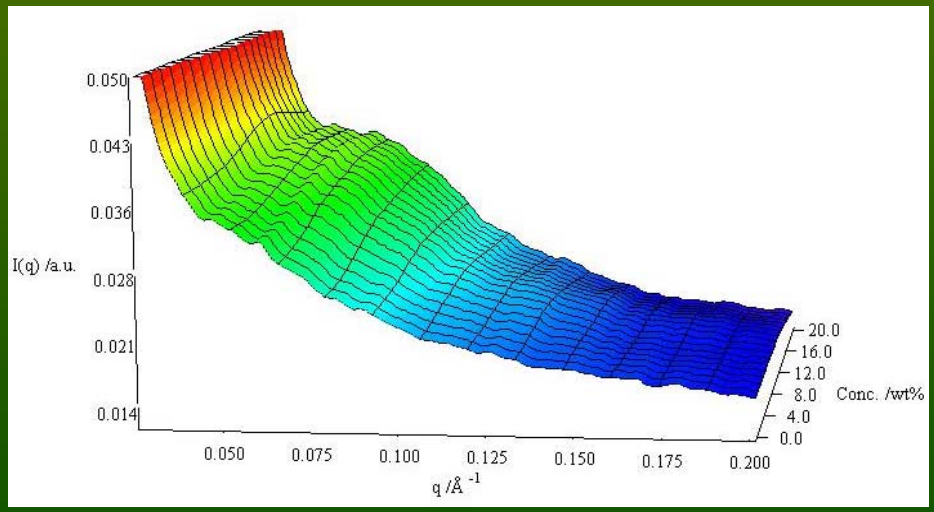
Solution Model

- 5 × 5 array produced
- Concentrations of 0 wt% to 20 wt%
- Effect of concentration and ionic strength on the vesicle structure studied.

Stock solution of 20 wt% EO(6) BO(11) in H_2O and pure H_2O



PDMS grid with Kapton™ windows

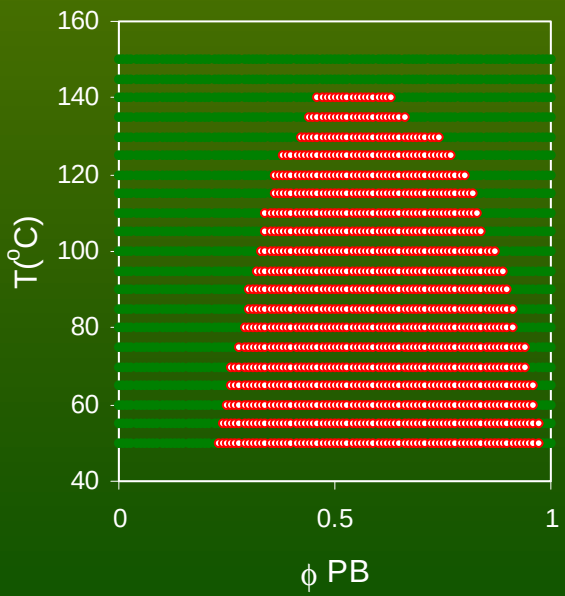


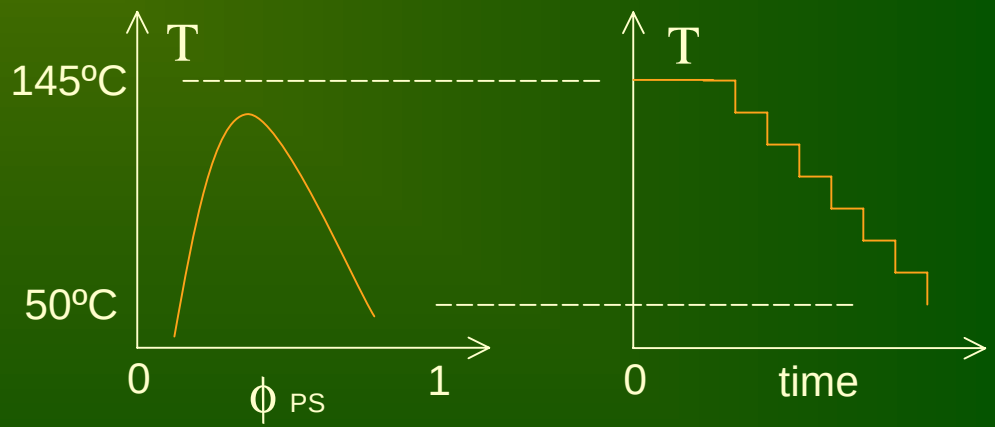
- Broad SAXS peak develops as concentration increases (lamellar structure within vesicle)
- No Bragg peaks develop in the WAXS (no crystallinity)
- Once the peak develops it shifts to higher q. (i.e. structure formed gets smaller ⇒ vesicle shell gets thinner)

A. Norman

Blends Model

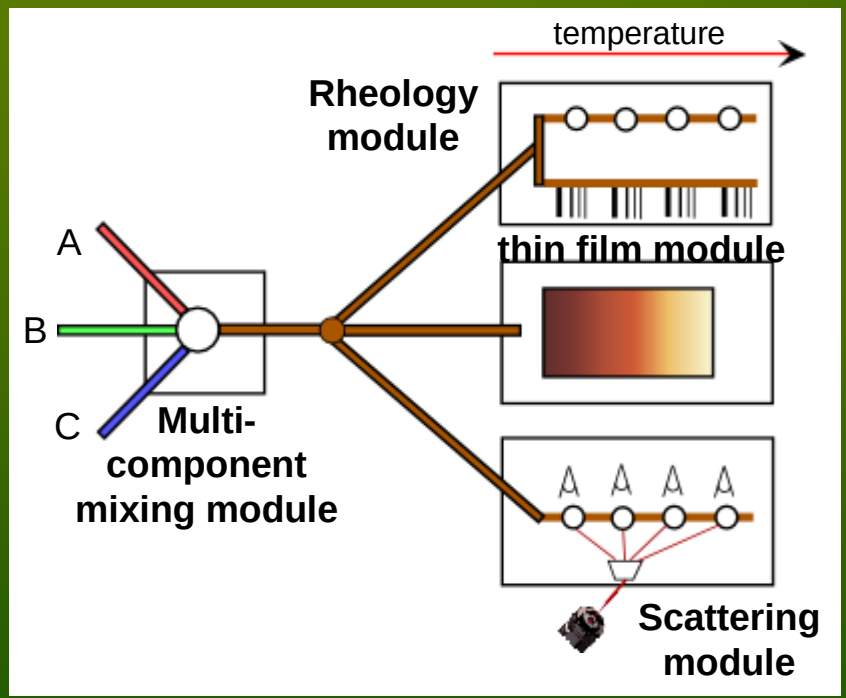
- PS/PB phase diagram
  - PS 2.35K / PB 2.8K
- Cloud point experiment
  - 100 microwells: ~1 μl volume each
  - 50μl of polymer → 100 compositions





J. Cabral

System Dependent Design



- Optimize existing methods for identified parameters
  - Varying polymer composition, formulation components and temperature
  - *Defining problem based on the choice of model (FP members)*
- Integrate techniques to measure and map properties
  - Composition, mixing, rheology, light scattering
  - Interfacing with flow coater and sample plates
  - Mechanical properties, morphology, stability, optical clarity
- Demonstrate automation and high throughput feedback
  - Monitoring and control mechanisms
  - Informatics link

Deliverables

Year 1

- Select suitable model polymer solution and polymer blend system and define parameters, variables, etc.
- Develop strategy to tailor investigation of the model systems using millifluidic and blend film coating techniques including prototype development, library generation, and analysis.
- Conduct preliminary tests

Year 2

- Test model systems using the tailored, integrated prototype measurement platform. Issues in library generation, high-throughput measurement, and analysis will be considered.
- Integrate the above system into the NCMC informatics database.
- Invite focused project members to investigate a suitable non-proprietary commercial solution or blend system to study cause effect relationships between parameters and performance using the integrated system developed and provide feedback for optimization.

Contributors

João Cabral, Howard J. Walls and Alex Norman